97. (New) The local area network as in claim 69, comprising only said at least three serial intelligent cells.

A marked-up version of the changes made to the specification and claims by the current amendment is attached, with the header "**VERSION WITH MARKINGS TO SHOW CHANGES MADE**".

REMARKS

Reconsideration of the above-identified patent application in view of the amendments above and the remarks following is respectfully requested.

Claims 1-3, 5-9, 12-34, 40, 47, 49-51, 53-57 and 60-71 are in this case. Claims 1-3, 5-9, 12-32, 40, 47, 49-51, 53, 56, 57, 60-66 and 69-71 have been rejected under § 103(a). Claims 33 and 34 have been objected to. Claims 54, 55, 67 and 68 have been allowed. Independent claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 have been amended. New claims 72-97 have been added.

The claims before the Examiner are directed toward a local area network based on serial intelligent cells (SICs) that are physically connected in a pairwise manner only by electrically-conducting media to form communicating pairs. The two SICs of each pair communicate with each other, bidirectionally, in full-duplex mode, and independent of any other pair, exclusively via the respective electrically-conducting media. In various embodiments, the electrically-conducting media include electrical power wiring or telephone wiring of a building; at least one of the media is used for both data exchange and either electrical power delivery, analog telephony or digital telephony; at least one of the SICs is powered from an electrical power main , from a

dedicated power line, or from the electrically-conducting media of its respective pair, or can itself deliver electrical power; or at least one of the pairs is partly housed within an electrical outlet. In other embodiments, one of the SICs includes a sensor or an actuator; one of the SICs is connected to a public telephone network interface; or the local area network functions as a multiplexer.

§ 103(a) Rejections - Markkula, Jr., et al. '690 in view of Sutterlin et al. '144

The Examiner has rejected claims 1-3, 5-9, 12-32, 40, 47, 49-51, 60-66 and 69-71 under § 103(a) as being unpatentable over Markkula, Jr., et al., U. S. Patent No. 4,918,690 (henceforth, "Markkula, Jr., et al. '690") in view of Sutterlin et al., U. S. Patent No. 5,148,144 (henceforth, "Sutterlin et al. '144"). Applicant presumes that the Examiner also intended to indicate rejection of claims 53, 56 and 57. The Examiner's rejection is respectfully traversed.

Markkula, Jr. et al. '690 teach a network of intelligent cells that communicate with each other via media that include electrically-conducting media such as power lines and twisted pairs. The crucial aspect of the present invention that Markkula, Jr. et al. '690 fail to teach is that each of the media provides a physical connection for no more than two of the cells.

As background for Applicant's argument that Markkula, Jr. et al. '690 fail to teach this aspect of the present invention, Applicant has attached copies of pages 16-19, 436-442 and 445-448 of William Stallings, *Data and Computer Communications*, fourth edition (Prentice Hall, 1994). Note in particular the definition of the lowest (physical) layer of the OSI model, as stated, for example, in Table 10.4 on page 438:

> Concerned with transmission of unstructured bit stream over physical medium; deals with the mechanical, electrical, functional, and procedural characteristics to access the physical medium

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The teachings of Markkula, Jr. et al. '690 are concerned almost exclusively with a network of intelligent cells from the point of view of OSI layers 2 and higher. For example, with the exception of Figure 4, whenever Markkula, Jr. et al. '690 discuss or illustrate pairwise connections of cells, the connection in question is a logical connection, not a physical connection. So, as a sub-example, the pairwise connections **59** etc. of the cells of Figure 5 are described as follows in column 7 lines 36-38:

> The lines between the cells such as line **59** is used to indicate which of the cells can communicate directly with one another...

The only explicit discussion of the physical layer in Markkula, Jr. et al. '690, from the point of view of network connectivity (as opposed to the physical structures of individual cells, as illustrated in Figure 1), is found in Figure 4 and the accompanying text in column 6 line 24 through column 7 line 6. Figure 4 illustrates a pair of channels, one of which includes three subchannels (A, B, D) and the other of which includes one subchannel (C). The cells of subchannel A communicate via twisted pair **50**. The cells of subchannel D communicate via twisted pair **52**. Subchannel B provides the physical connection between subchannels A and D: cell **56**, that is common to subchannels A and B, and cell **57**, that is common to subchannels B and D, communicate via twisted pair **72**. It is purely coincidental that twisted pair **72** connects exactly two cells. Markkula, Jr. et al. '690 teach in Figure 4 that no matter how many cells are present in a subchannel, all of these cells should communicate over the same medium, as in the prior art bus topology discussed in the above-identified patent application on page 1 line 4 through page 2 line 11. There is neither a hint nor a suggestion in Markkula, Jr. et al. '690 of any utility whatsoever to

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requiring pairwise physical connection of all the cells of an intelligent cell network, as in the present invention.

While continuing to traverse the Examiner's rejections, Applicant, in order to expedite the prosecution, has chosen to amend independent claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 in order to clarify and emphasize the crucial distinctions between the present invention and the teachings of Markkula., Jr. et al. '690. Specifically, claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 have been amended to clarify that each of the electrically-conducting media physically interconnects no more than two of the serial intelligent cells.

Support for this amendment is found in several places in the specification. That the present invention is directed at the "physical layer" is stated on page 18 lines 9-15, which discusses the advantage of the network of the present invention over the network of Markkula, Jr. et al. '690 in terms of the differing physical structures of the two networks:

> As another example, in the network disclosed in U.S. Patent No. 4,918,690 to Markkula et al. (hereinafter referred to as "Markkula"), this fault affects the physical layer by disabling the media's signal-carrying capability. The Token Ring network will not function at all since the data layer functionality based on unidirectional transmission will not be supported. In contrast, however, a SIC network according to the present invention, will continue to function fully, except for the specific faulty link itself. All other links continue to function normally. (emphasis added)

Explicit reference to the physical layer also is made on page 8 lines 3-9, as amended in response to the second Office Action:

> Furthermore, every communication between SIC's is a "point-to-point communication", which term herein denotes a communication that takes place between exactly one sender and exactly one receiver. This is in contrast to a bus-based communication, in which there are many (potential) receivers and many (potential) senders. Consequently, in the topology according to the present invention, there is automatically a termination in the physical layer at each end of a connection (a SIC),

> both simplifying the installation and insuring more reliable communication. (emphasis added)

Note that the above citation from page 8 lines 3-9 refers explicitly to the pairs of serial intelligent cells being physical terminations of their respective connections.

The physical connectivity of the network of the present invention also is discussed on page 19 lines 19-23 in the context of retrofitting the present invention to existing wiring. In particular, page 19 lines 21-22 state that

> In order to use SIC technology, the wiring must be broken, and a SIC installed between both ends.

Such an installation of SICs in the existing wiring inherently produces a network in which each electrically-conducting media physically interconnects exactly two SICs. Finally, the discussion of installing the present invention in a manner that supports telephony, on page 20 line 19 through page 21 line 13, includes the following instructions for reverting to prior art telephony in case of network failure, on page 21 lines 10-13:

> This can be improved by means of a system which disconnects the SIC's circuitry and restores the original wiring routing (this can be easily implemented by relays, which bypass the SIC's upon failure detection, manual intervention, or other relevant occasion).

If the SICs must be disconnected to restore the original wiring routing, then the SICs must have been connected as described on page 19 lines 19-21, with each electrically-conducting media physically interconnecting exactly two SICs.

Another difference between the present invention that is not taught by Markkula, Jr. et al. '690, and that is not obvious from Markkula, Jr. et al. '690, is the nature of the bidirectional communication between the pairs of serial intelligent cells of the present invention. By way of background, Applicant respectfully directs the

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Examiner's attention to page 34 (also attached) of the Stallings book, in the third paragraph of which, simplex, half-duplex and full duplex transmissions are defined:

> A transmission may be simplex, half-duplex or full duplex. In *simplex* transmission, signals are transmitted in only one direction; one station is transmitter and the other is receiver. In *half-duplex* operation, both stations may transmit, but only one at a time. In *full-duplex* operation, both stations may transmit simultaneously.

That Markkula, Jr. et al. '690 find it necessary to provide a protocol for dealing with contention (column 68 line 6 through column 71 line 41) shows that their transmissions are half-duplex. Although the description starting at column 7 line 29 of Markkula, Jr. et al. '690 assumes that the intelligent cells communicate without interfering with each other, column 7 lines 63-68 states explicitly that this is only a simplifying assumption for the sake of expositional clarity. Formally, the network of Markkula, Jr. et al. '690 supports bidirectional communication, but this is only because of their use of a "bidirectional communication protocol" (column 3 lines 38-39; emphasis added).

By contrast, all pairwise communication among the serial intelligent cells of the present invention is full duplex. Condition (d) of claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 states that each communicating pair of the present invention is operative to communicate bidirectionally. Page 7 lines 23-24 of the specification defines "bidirectional communication" as equivalent to "'full duplex' communication". It is not at all obvious from Markkula et al. '690 that a network of intelligent cells can be constructed that is inherently bidirectional by virtue of using full duplex communication and that does not need a special protocol to obtain functionally bidirectional communication.

To emphasize this distinction between the present invention and the teachings of Markkula, Jr. et al. '690, claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 have been

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amended to state, in conditions (c) thereof, that each communicating pair engages in a full duplex communication. Support for this amendment is found in the specification on page 7 lines 23-24 as cited above.

Because the teachings of Markkula, Jr. et al. '690 could be construed as reading on the present invention in the trivial special case of a network that consists of only two serial intelligent cells, claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 also have been amended to recite at least three serial intelligent cells interconnected exclusively by electrically-conducting media into at least two communicating pairs. Support for this amendment is found in the specification in Figure 10 and the accompanying text. Figure 10 shows a network of the present invention that includes SICs **1006** and **1010**, with electrically-conducting medium **1008** emerging from SIC **1006**, and with the ellipses (...) indicating (page 22 lines 15-17):

> ...that additional SIC's and electrically-conducting media may be present in the local area network between SIC **1006** and SIC **1010**.

New claims 80-97, that depend from claims 1, 40, 47, 53, 60, 61, 64, 66 and 69, have been added to recite further limitations that distinguish the present invention from the teachings of Markkula, Jr. et al. '690. New claims 80-88 recite the situation that is illustrated explicitly in Figure 9: (at least) four serial intelligent cells **900**, **902**, **904** and **906** interconnected into (at least) three communicating pairs. New claims 89-97 recite the limitation that the network of the present invention comprises only the at least three intelligent cells of those claims' respective independent claims, to preclude the misunderstanding of those independent claims (as now amended) as reading on a situation not taught by Markkula, Jr. et al '690 but obvious from Markkula, Jr. et al. '690: a network similar to the network of Figure 4 of Markkula, Jr. et al. '690 but including six subchannels, two of which, like subchannel B, include only two cells,

each of which cell is shared with another subchannel that includes many other cells that share the same medium.

So far, Applicant has discussed the patentability of claims 1, 40, 47, 53, 60, 61, 64, 66 and 69, as now amended, over Markkula, Jr. '690 considered in isolation. In fact, as noted above, the Examiner has rejected these claims as unpatentable over the combination of Markkula, Jr. et al. '690 and Sutterlin et al. '144. However, as admitted by the Examiner, the teachings of Sutterlin et al. '144 are relevant only to limitations of these claims that have nothing to do with the distinctions between the present invention and the teachings of Markkula Jr., et al. '690 that are discussed above and that now are recited in claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 as amended. Therefore, claims 1, 40, 47, 53, 60, 61, 64, 66 and 69, as now amended, are patentable, not only over Markkula, Jr. et al. '690 considered in isolation, but also over the combination of Markkula, Jr. et al. '690 and Sutterlin et al. '144.

With independent claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 and allowable in their present form, it follows that claims 2, 3, 5-9, 12-32, 49-51, 53, 56, 57, 62, 63, 65, 70 and 71, that depend therefrom, also are allowable.

Applicant has taken the liberty of attaching a set of notes that elaborate on the differences between the present invention and the teachings of Markkula, Jr. et al. '690 and Sutterlin et al. '144, including both the differences discussed above and other differences.

Objections

The Examiner has objected to claims 33 and 34 as being based on rejected base claims. The Examiner has noted that claims 33 and 34 would be allowable if

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rewritten in independent form including all the limitations of the base claim and any intervening claim.

New claim 72 is claim 33 rewritten in independent form. New claim 73 is claim 34 rewritten to depend from claim 72.

Other New Claims

As noted above, Markkula, Jr. et al. '690 teach a network of intelligent cells that communicate with each other via media that include electrically-conducting media such as power lines and twisted pairs. These intelligent cells do not receive their power directly (if at all) from the communication media, unlike the intelligent cells of the present invention, which receive their power directly from the communication media. For example, SIC **500** of Figure 5 of the above-identified application receives both power and data from electrically-conducting medium **503** and separates the power from the data using power/data splitter/combiner **504**.

Sutterlin et al. '144 teach a similar network of (unintelligent) communication nodes. In the invention itself of Sutterlin et al. '144, the nodes communicate and receive power over different sets of electrically-conducting media, and thus is irrelevant to the present invention. For example, in the network of Figure 5, nodes **33** and **34** receive DC power via twisted pair **53** while communicating via twisted pair **52**. Nevertheless, Sutterlin et al. '144 cite as prior art the system of Figure 1, in which nodes **10** and **13** receive DC power and communicate via the same twisted pair **15**. In rejecting claims 1-3, 5-9, 12-32, 40, 47, 49-51, 53, 56, 57, 60-66 and 69-71, the Examiner apparently was of the opinion that it would be obvious to use this prior art DC power/data scheme in the context of the intelligent cell network of Markkula, Jr.,

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et al. '690, thereby obtaining the present invention as recited in these claims prior to the amendments discussed above.

Two more aspects of the present invention, that have nothing to do with whether the interconnections between the serial intelligent cells are logical interconnections or physical interconnections, are not obvious from the combination of Markkula, Jr., et al. '690 and Sutterlin et al. '144, because of an inherent limitation in the prior art system of Figure 1 of Sutterlin et al. '144. Specifically, this prior art system, which relies on capacitor **17** to separate "AC communications" (column 1 line 24) from DC power, is inherently limited, both to DC power and to a single communications channel. By contrast, the present invention is operative to carry both power and <u>two</u> channels of data via the electrically-conducting media, as illustrated in Figure 6 for the case of one data channel being a local area network data channel and the other channel being a telephony channel. In SIC **600** of Figure 6, telephony/data splitter/combiners **604** and **610** decouple local area network data, telephony data and power received from electrically conducting media **603** and **615** to modems **606** and **612**, power/telephone interface **624** and power supply **620**; or alternatively couple local area network data from modems **606** and **612**, telephony data from power/telephone interface **624** and power from power supply **620** into electrically conducting media **603** and **615**. Furthermore, the present invention is operative to carry AC power via the electrically-conducting media, as illustrated in Figure 5. In SIC **500** of Figure 5,

> power/data splitter/combiner **504** is an AC power/data splitter/combiner, which separates a low-frequency alternating current power from the higher-frequency data signal.

(page 11 lines 14-16) Neither of these aspects of the present invention is obvious from Sutterlin et al. '144.

New independent claims 74 and 78 are identical to independent claims 47 and 60 prior to their amendment as discussed above. New claims 75-77, that depend from new independent claim 74, correspond to claims 49-51. New independent claims 74 and 78 recite the illustrated special case (telephony/data splitter/combiner) of Figure 6. Therefore, new independent claims 74 and 78 are allowable over the prior art cited by the Examiner. It follows that claims 75-77, that depend from claim 74, also are allowable.

New independent claim 79 is identical to claim 61, prior to the amendment of claim 61 as described above, with the inclusion of the limitations of claim 62, which recites the illustrated special case (AC power/data splitter/combiner) of Figure 5. As such, new independent claim 79 is allowable over the prior art cited by the Examiner.

In view of the above amendments and remarks it is respectfully submitted that independent claims 1, 40, 47, 53, 54, 60, 61, 64, 66, 67, 69, 72, 74, 78 and 79 and hence dependent claims 2, 3, 5-9, 12-34, 49-51, 55-57, 62, 63, 65, 68, 70, 71, 73, 75-77 and 80-97 are in condition for allowance. Prompt notice of allowance is respectfully and earnestly solicited.

Respectfully submitted,

Mark M. Friedman
Attorney for Applicant
Registration No. 33,883

Date: September 6, 2001

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the claims:

Claims 1, 40, 47, 53, 60, 61, 64, 66 and 69 have been amended as follows:

1. (Thrice Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** at least three serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** two communicating pairs, wherein:

(a) each of said electrically-conducting media physically interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a full duplex communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said electrically-conducting media is used to carry both local area network data and electrical power; and wherein the local area

network data and electrical power are combined using frequency-domain multiplexing.

40. (Twice Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** <u>at least three</u> serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** <u>two</u> communicating pair<u>s</u>, wherein:

(a) each of said electrically-conducting media <u>physically</u> interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a <u>full duplex</u> communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media is used to carry both local area network data and electrical power; and wherein the local area network data and electrical power are combined using frequency-domain multiplexing.

47. (Twice Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** <u>at least three</u> serial intelligent cells

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interconnected exclusively by electrically-conducting media into at least **[one]** two communicating pairs, wherein:

(a) each of said electrically-conducting media physically interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a full duplex communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises a telephony/data splitter/combiner.

53. (Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** at least three serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** two communicating pairs, wherein:

(a) each of said electrically-conducting media physically interconnects no more than two of said serial intelligent cells;

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(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a full duplex communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair.

wherein at least one of said plurality of serial intelligent cells comprises:

(a) a line interface;

(b) a modem;

(c) a control block;

(d) a power supply; and

(e) a telephone interface;

and wherein one of said plurality of serial intelligent cells is interconnected to a public telephone network interface.

60. (Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** at least three serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** two communicating pairs, wherein:

(a) each of said electrically-conducting media physically interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a <u>full duplex</u> communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises a telephony/data splitter/combiner.

61. (Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** <u>at least three</u> serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** <u>two</u> communicating pair<u>s</u>, wherein:

(a) each of said electrically-conducting media <u>physically</u> interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a full duplex communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises a power/data splitter/combiner.

64. (Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** at least three serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** two communicating pairs, wherein:

(a) each of said electrically-conducting media physically interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a full duplex communication exclusively over said electrically-conducting media; and

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(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; and wherein at least one of said plurality of serial intelligent cells comprises:

(i) a line interface,

(ii) a modem,

(iii) a control block,

(iv) a power supply, and

(v) a computer bus connector.

66. (Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** <u>at least three</u> serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** <u>two</u> communicating pair<u>s</u>, wherein:

(a) each of said electrically-conducting media <u>physically</u> interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a <u>full duplex</u> communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said plurality of serial intelligent cells comprises:

(i) a line interface,

(ii) a modem,

(iii) a control block,

(iv) a power supply, and

(v) a telephone interface;

and wherein one of said plurality of serial intelligent cells is interconnected to a public telephone network interface.

69. (Amended) A local area network for data communication, sensing, and control comprising **[a plurality of]** <u>at least three</u> serial intelligent cells interconnected exclusively by electrically-conducting media into at least **[one]** <u>two</u> communicating pair<u>s</u>, wherein:

(a) each of said electrically-conducting media <u>physically</u> interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

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(c) each of said at least one communicating pair engages in a full duplex communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises a power/data splitter/combiner.

New claims 72-97 have been added as follows:

72. (New) A local area network for data communication, sensing, and control comprising a plurality of serial intelligent cells interconnected exclusively by electrically-conducting media into at least one communicating pair, wherein:

(a) each of said electrically-conducting media interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a communication exclusively over said electrically-conducting media; and

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(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said electrically-conducting media is used to carry both local area network data and electrical power; and wherein the local area network data and electrical power are combined using frequency-domain multiplexing, the local area network functioning as a multiplexer, wherein at least one of said plurality of serial intelligent cells is connected to a high data rate connection whose bandwidth is multiplexed to at least one other of said plurality of serial intelligent cells.

73. (New) The local area network as in claim 72, functioning as a voice multiplexer, wherein at least one of said plurality of serial intelligent cells is connected to a telephone.

74. (New) A local area network for data communication, sensing, and control comprising a plurality of serial intelligent cells interconnected exclusively by electrically-conducting media into at least one communicating pair, wherein:

(a) each of said electrically-conducting media interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

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(c) each of said at least one communicating pair engages in a communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises a telephony/data splitter/combiner.

75. (New) The local area network as in claim 74, wherein at least one of said plurality of serial intelligent cells comprises a power/data splitter/combiner.

76. (New) The local area network as in claim 75, wherein said power/data splitter/combiner comprises an AC power/data splitter/combiner.

77. (New) The local area network as in claim 75, wherein said power/data splitter/combiner comprises a DC power/data splitter/combiner.

78. (New) A local area network for data communication, sensing, and control comprising a plurality of serial intelligent cells interconnected exclusively by electrically-conducting media into at least one communicating pair, wherein:

(a) each of said electrically-conducting media interconnects no more than two of said serial intelligent cells;

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(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises a telephony/data splitter/combiner.

79. (New) A local area network for data communication, sensing, and control comprising a plurality of serial intelligent cells interconnected exclusively by electrically-conducting media into at least one communicating pair, wherein:

(a) each of said electrically-conducting media interconnects no more than two of said serial intelligent cells;

(b) each of said at least one communicating pair includes one of said electrically-conducting media and exactly two of said serial intelligent cells;

(c) each of said at least one communicating pair engages in a communication exclusively over said electrically-conducting media; and

(d) each of said at least one communicating pair is operative to engage in said communication bidirectionally and independently of the communication of any other of said at least one communicating pair;

wherein at least one of said electrically-conducting media includes electrical power wiring of a building; wherein at least one of said plurality of serial intelligent cells receives electrical power via said electrically-conducting media; and wherein at least one of said plurality of serial intelligent cells comprises an AC power/data splitter/combiner.

80. (New) The local area network as in claim 1, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

81. (New) The local area network as in claim 40, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

82. (New) The local area network as in claim 47, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

d

83. (New) The local area network as in claim 53, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

84. (New) The local area network as in claim 60, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

85. (New) The local area network as in claim 61, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

86. (New) The local area network as in claim 64, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

87. (New) The local area network as in claim 66, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

88. (New) The local area network as in claim 69, comprising at least four said serial intelligent cells interconnected exclusively by said electrically-conducting media into at least three communicating pairs.

d

89. (New) The local area network as in claim 1, comprising only said at least three serial intelligent cells.

90. (New) The local area network as in claim 40, comprising only said at least three serial intelligent cells.

91. (New) The local area network as in claim 47, comprising only said at least three serial intelligent cells.

92. (New) The local area network as in claim 53, comprising only said at least three serial intelligent cells.

93. (New) The local area network as in claim 60, comprising only said at least three serial intelligent cells.

94. (New) The local area network as in claim 61, comprising only said at least three serial intelligent cells.

95. (New) The local area network as in claim 64, comprising only said at least three serial intelligent cells.

96. (New) The local area network as in claim 66, comprising only said at least three serial intelligent cells.

97. (New) The local area network as in claim 69, comprising only said at least three serial intelligent cells.

DATA AND COMPUTER COMMUNICATIONS

FOURTH EDITION

William Stallings, Ph.D.

Prentice Hall International, Inc.

To my loving wife, Tricia

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protocol performs the same calculation and compares the result with the incoming code. A discrepancy results if there has been some error in transmission. In that case, the receiver can discard the PDU and take corrective action.

The next step is for the transport layer to hand each protocol data unit over to the network layer, with instructions to transmit it to the destination computer. To satisfy this request, the network access protocol must present the data to the network with a request for transmission. As before, this operation requires the use of control information. In this case, the network access protocol appends a network access header to the data it receives from the transport layer, creating a network-access PDU. Examples of the items that may be stored in the header include

- *Destination computer address:* The network must know to whom (which computer on the network) the data are to be delivered.
- *Facilities requests:* The network access protocol might want the network to make use of certain facilities, such as priority.

Figure 1.9 puts all of these concepts together, showing the interaction between modules to transfer one block of data. Let us say that the file transfer module in computer X is transferring a file one record at a time to computer Y. Each record is handed over to the transport layer module. We can picture this action as being in the form of a command or procedure call, A-SEND (application-send). The arguments of this procedure call include the destination computer address, the destination service access point, and the record. The transport layer appends the destination service access point and other control information to the record to create a transport PDU. This is then handed down to the network access layer in a T-SEND command. In this case, the arguments for the command are the destination computer address and the transport protocol data unit. The network access layer uses this information to construct a network PDU. The transport protocol data unit is the data field of the network PDY, and the network PDU header includes information concerning the source and destination computer addresses.

The network accepts the network PDU from X and delivers it to Y. The network access module in Y receives the PDU, strips off the header, and transfers the enclosed transport PDU to X's transport layer module. The transport layer examines the transport protocol data unit header and, on the basis of the SAP field in the header, delivers the enclosed record to the appropriate application, in this case the file transfer module in Y.

The OSI Model

Figure 1.7 suggests that the various elements of the structured set of protocols are layered, or form a hierarchy. This concept is also evident in Figure 1.10, which depicts the open systems interconnection (OSI) model. The OSI model was developed by the International Organization for Standardization as a

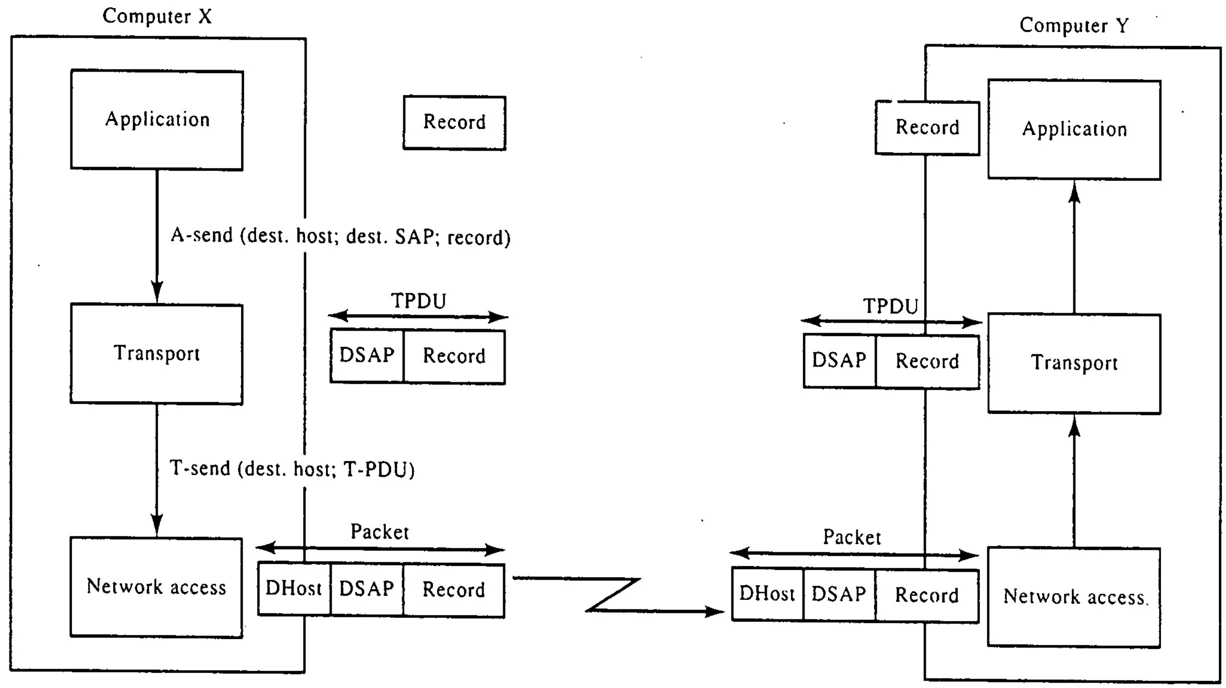


FIGURE 1.9. Operation of a communications architecture.

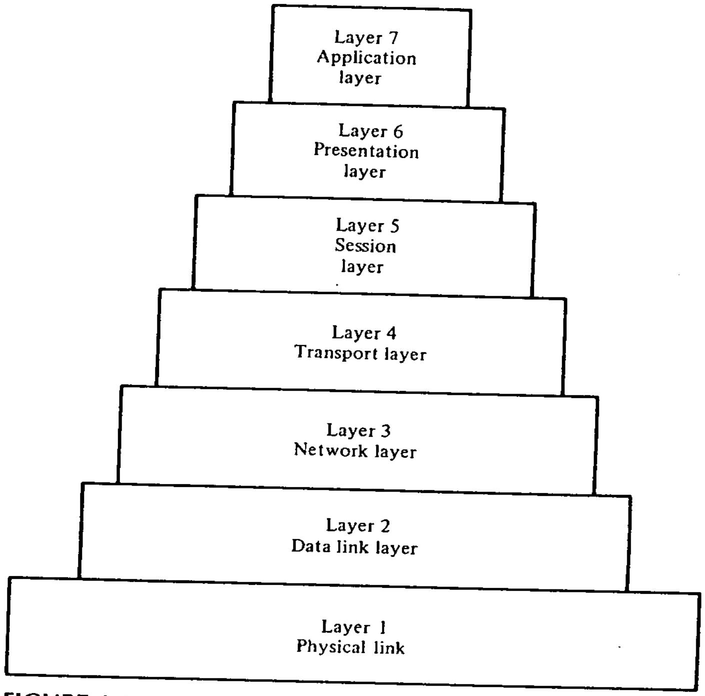


FIGURE 1.10. Open systems interconnection model.

TABLE 1.3 The OSI Layers

1. Physical	Concerned with transmission of unstructured bit stream over physical medium; deals with the mechanical, electrical, functional, and procedural characteristics to access the physical medium
2. Data link	Provides for the reliable transfer of information across the physical link; sends blocks of data (frames) with the necessary synchronization, error control, and flow control
3. Network	Provides upper layers with independence from the data transmission and switching technologies used to connect systems; responsible for establishing, maintaining, and terminating connections
4. Transport	Provides reliable, transparent transfer of data between end points; provides end-to-end error recovery and flow control
5. Session	Provides the control structure for communication between applications; establishes, manages, and terminates connections (sessions) between cooperating applications
6. Presentation	Provides independence to the application processes from differences in data representation (syntax)
7. Application	Provides access to the OSI environment for users and also provides distributed information services

model for a computer communications architecture, and as a framework for developing protocol standards. Table 1.3 briefly defines the functions performed at each layer. The intent of the OSI model is that protocols be developed to perform the functions of each layer. Part III of this book will examine protocols in detail and make use of this model for that purpose.

1.6 STANDARDS-MAKING ORGANIZATIONS

It has long been accepted in the communications industry that standards are required to govern the physical, electrical, and procedural characteristics of communication equipment. In the past, this view has not been embraced by the computer industry. Whereas communication equipment vendors recognize that their equipment will generally interface to and communicate with other vendors' equipment, computer vendors have traditionally attempted to monopolize their customers. The proliferation of computers and distributed processing has made that an untenable position. Computers from different vendors must communicate with each other and, with the ongoing evolution of protocol standards, customers will no longer accept special-purpose protocol conversion software development. The result is that standards now permeate all of the areas of technology discussed in this book.

Throughout the book, especially in Part III, we will describe the most important standards that are in use or being developed for various aspects of data and computer communications. The appendix to this chapter looks at the key organizations involved with the development of standards.

There are a number of advantages and disadvantages to the standards-making process. We list here the most striking ones. The principal advantages of standards are

- A standard assures that there will be a large market for a particular piece of equipment or software. This encourages mass production and, in some cases, the use of large-scale-integration (LSI) or very-large-scale-integration (VLSI) techniques, resulting in lower costs.
- A standard allows products from multiple vendors to communicate, giving the purchaser more flexibility in equipment selection and use.

The principal disadvantages are

- A standard tends to freeze the technology. By the time a standard is developed, subjected to review and compromise, and promulgated, more efficient techniques are possible.
- There are multiple standards for the same thing. This is not a disadvantage of standards per se, but of the current way things are done. Fortunately, in recent years the various standards-making organizations have begun to co-

media are twisted pair, coaxial cable, and optical fiber. *Unguided media* provide a means for transmitting electromagnetic waves but do not guide them; examples are propagation through air, vacuum, and seawater.

The term *direct link* is used to refer to the transmission path between two devices in which signals propagate directly from transmitter to receiver with no intermediate devices, other than amplifiers or repeaters used to increase signal strength. Both parts of Figure 2.1 depict a direct link. Note that this term can apply to both guided and unguided media.

A guided transmission medium is *point-to-point* if it provides a direct link between two devices and those are the only two devices sharing the medium (Figure 2.1a). In a *multipoint* guided configuration, more than two devices share the same medium (Figure 2.1b).

A transmission may be simplex, half-duplex, or full duplex. In *simplex* transmission, signals are transmitted in only one direction; one station is transmitter and the other is receiver. In *half-duplex* operation, both stations may transmit, but only one at a time. In *full-duplex* operation, both stations may transmit simultaneously. In the latter case, the medium is carrying signals in both directions at the same time. How this can be is explained in due course.

We should note that the definitions just given are the ones in common use in the United States (ANSI definitions). In Europe (CCITT definitions), the term "simplex" is used to correspond to half-duplex as defined above, and "duplex" is used to correspond to full-duplex as defined above.

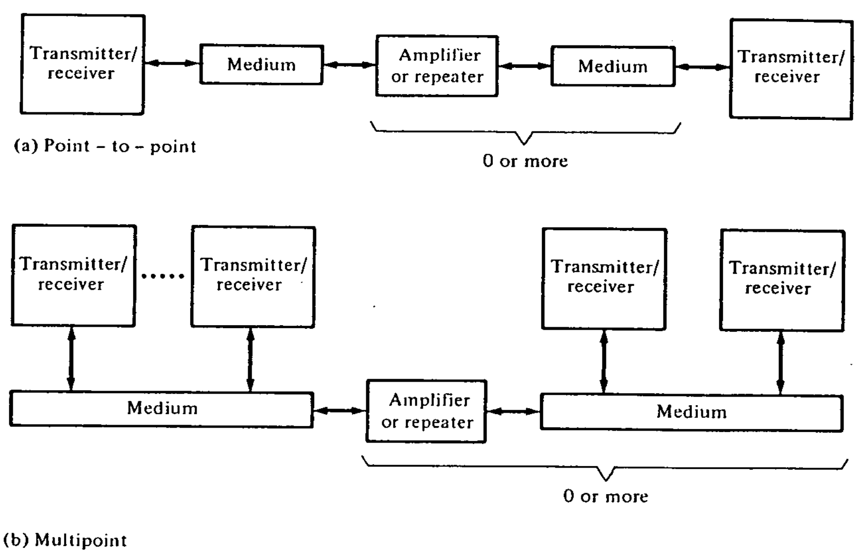


FIGURE 2.1. Guided transmission configurations.

All of these services depend on the underlying transmission system and any intervening lower-level entities. If it is possible for these services to be provided from below, the protocol can be used by the two entities to exercise those services.

10.2 THE OSI MODEL

Motivation

When work is done that involves more than one computer, additional elements must be added to the system: the hardware and software to support the communication between or among the systems. Communications hardware is reasonably standard and generally presents few problems. However, when communication is desired among heterogeneous (different vendors, different models of same vendor) machines, the software development effort can be a nightmare. Different vendors use different data formats and data exchange conventions. Even within one vendor's product line, different model computers may communicate in unique ways.

As the use of computer communications and computer networking proliferates, a one-at-a-time special-purpose approach to communications software development is too costly to be acceptable. The only alternative is for computer vendors to adopt and implement a common set of conventions. For this to happen, a set of international or at least national standards must be promulgated by appropriate organizations. Such standards have two effects:

- Vendors feel encouraged to implement the standards because of an expectation that, because of wide usage of the standards, their products would be less marketable without them.
- Customers are in a position to require that the standards be implemented by any vendor wishing to propose equipment to them.

It should become clear from the ensuing discussion that no single standard will suffice. The task of communication in a truly cooperative way between applications on different computers is too complex to be handled as a unit. The problem must be decomposed into manageable parts. Hence before one can develop standards, there should be a structure or *architecture* that defines the communications tasks.

This line of reasoning led the International Organization for Standardization (ISO) in 1977 to establish a subcommittee to develop such an architecture. The result was the *Open Systems Interconnection* (OSI) reference model, adopted in 1983, which is a framework for defining standards for linking heterogeneous computers. The OSI model provides the basis for connecting "open" systems for distributed applications processing. The term "open" denotes the ability of

TABLE 10.2 Purpose of the OSI Model

The purpose of this International Standard Reference Model of Open Systems Interconnection is to provide a common basis for the coordination of standards development for the purpose of systems interconnection, while allowing existing standards to be placed into perspective within the overall Reference Model.

The term Open Systems Interconnection (OSI) qualifies standards for the exchange of information among systems that are "open" to one another for this purpose by virtue of their mutual use of the applicable standards.

The fact that a system is open does not imply any particular systems implementation, technology or means of interconneciton, but refers to the mutual recognition and support of the applicable standards.

It is also the purpose of this International Standard to identify areas for developing or improving standards, and to provide a common reference for maintaining consistency of all related standards. It is not the intent of this International Standard either to serve as an implementation specification, or to be a basis for appraising the conformance of actual implementations, or to provide a sufficient level of detail to define precisely the services and protocols of the interconnection architecture. Rather, this International Standard provides a conceptual and functional framework which allows international teams of experts to work productively and independently on the development of standards for each layer of the Reference Model of OSI.

any two systems conforming to the reference model and the associated standards to connect.

Table 10.2, extracted from the basic OSI document [ISO84] summarizes the purpose of the model.

Concepts

A widely accepted structuring technique, and the one chosen by ISO, is *layering*. The communications functions are partitioned into a vertical set of layers. Each layer performs a related subset of the functions required to communicate with another system. It relies on the next lower layer to perform more primitive functions and to conceal the details of those functions. It provides services to the next higher layer. Ideally, the layers should be defined so that changes in one layer do not require changes in the other layers. Thus we have decomposed one problem into a number of more manageable subproblems.

The task of the ISO subcommittee was to define a set of layers and the services performed by each layer. The partitioning should group functions logically, should have enough layers to make each layer manageably small, but should not have so many layers that the processing overhead imposed by the collection of layers is burdensome. The principles by which ISO went about its task are summarized in Table 10.3. The resulting OSI reference model has seven layers, which are listed with a brief definition in Table 10.4. Table 10.5 provides ISO's justification for the selection of these layers.

TABLE 10.3 Principles Used in Defining the OSI Layers

1. Do not create so many layers as to make the system engineering task of describing and integrating the layers more difficult than necessary.
2. Create a boundary at a point where the description of services can be small and the number of interactions across the boundary are minimized.
3. Create separate layers to handle functions that are manifestly different in the process performed or the technology involved.
4. Collect similar functions into the same layer.
5. Select boundaries at a point which past experience has demonstrated to be successful.
6. Create a layer of easily localized functions so that the layer could be totally redesigned and its protocols changed in a major way to take advantage of new advances in architectural, hardware or software technology without changing the services expected from and provided to the adjacent layers.
7. Create a boundary where it may be useful at some point in time to have the corresponding interface standardized.
8. Create a layer where there is a need for a different level of abstraction in the handling of data (e.g., morphology, syntax, semantics).
9. Allow changes of functions or protocols to be made within a layer without affecting other layers.
10. Create for each layer boundaries with its upper and lower layer only.

Similar principles have been applied to sublayering:

11. Create further subgrouping and organization or functions to form sublayers within a layer in cases where distinct communication services need it.
12. Create, where needed, two or more sublayers with a common, and therefore minimal functionality to allow interface operation with adjacent layers.
13. Allow bypassing of sublayers.

TABLE 10.4 The OSI Layers

1. Physical	Concerned with transmission of unstructured bit stream over physical medium; deals with the mechanical, electrical, functional, and procedural characteristics to access the physical medium
2. Data link	Provides for the reliable transfer of information across the physical link; sends blocks of data (frames) with the necessary synchronization, error control, and flow control
3. Network	Provides upper layers with independence from the data transmission and switching technologies used to connect systems; responsible for establishing, maintaining, and terminating connections
4. Transport	Provides reliable, transparent transfer of data between end points; provides end-to-end error recovery and flow control
5. Session	Provides the control structure for communication between applications; establishes, manages, and terminates connections (sessions) between cooperating applications
6. Presentation	Provides independence to the application processes from differences in data representation (syntax)
7. Application	Provides access to the OSI environment for users and also provides distributed information services

TABLE 10.5 Justification of the OSI Layers

a. It is essential that the architecture permit usage of a realistic variety of physical media for interconnection with different control procedures (e.g., V.24, V.25, X.21, etc.). Application of principles 3, 5, and 8 [Table 10.3] leads to indentification of a *Physical Layer* as the lowest layer in the architecture.
b. Some physical communication media (e.g., telephone line) require specific techniques to be used in order to transmit data between systems despite a relatively high error rate (i.e., an error rate not acceptable for the great majority of applications). These specific techniques are used in data-link control procedures which have been studied and standardized for a number of years. It must also be recognized that new physical communication media (e.g., fiber optics) will require different data-link control procedures. Application of principles 3, 5, and 8 leads to identification of a *Data Link Layer* on top of the Physical Layer in the architecture.
c. In the open systems architecture, some systems will act as the final destination of data. Some systems may act only as intermediate nodes (forwarding data to other systems). Application of principles 3, 5, and 7 leads to identification of a *Network Layer* on top of the Data Link Layer. Network oriented protocols such as routing, for example, will be grouped in this layer. Thus, the Network Layer will provide a connection path (network-connection) between a pair of transport-entities, including the case where intermediate nodes are involved.
d. Control of data transportation from source end-system to destination end-system (which is not performed in intermediate nodes) is the last function to be performed in order to provide the totality of the transport-service. Thus, the upper layer in the transport-service part of the architecture is the *Transport Layer*, on top of the Network Layer. This Transport Layer relieves higher layer entities from any concern with the transportation of data between them.
e. There is a need to organize and synchronize dialogue, and to manage the exchange of data. Application of principles 3 and 4 leads to the identification of a *Session Layer* on top of the Transport Layer.
f. The remaining set of general interest functions are those related to representation and manipulation of structured data for the benefit of application programs. Application of principles 3 and 4 leads to identification of a *Presentation Layer* on top of the Session Layer.
g. Finally, there are applications consisting of application processes which perform information processing. An aspect of these application processes and the protocols by which they communicate comprise the *Application Layer* as the highest layer of the architecture.

Table 10.4 defines, in general terms, the functions that must be performed in a system for it to communicate. Of course, it takes two to communicate, so the same set of layered functions must exist in two systems. Communication is achieved by having corresponding ("peer") entities in the same layer in two different systems communicate via a protocol.

Figure 10.7 illustrates the OSI model. Each system contains the seven layers. Communication is between applications in the systems, labeled application X and application Y in the figure. If application X wishes to send a message to

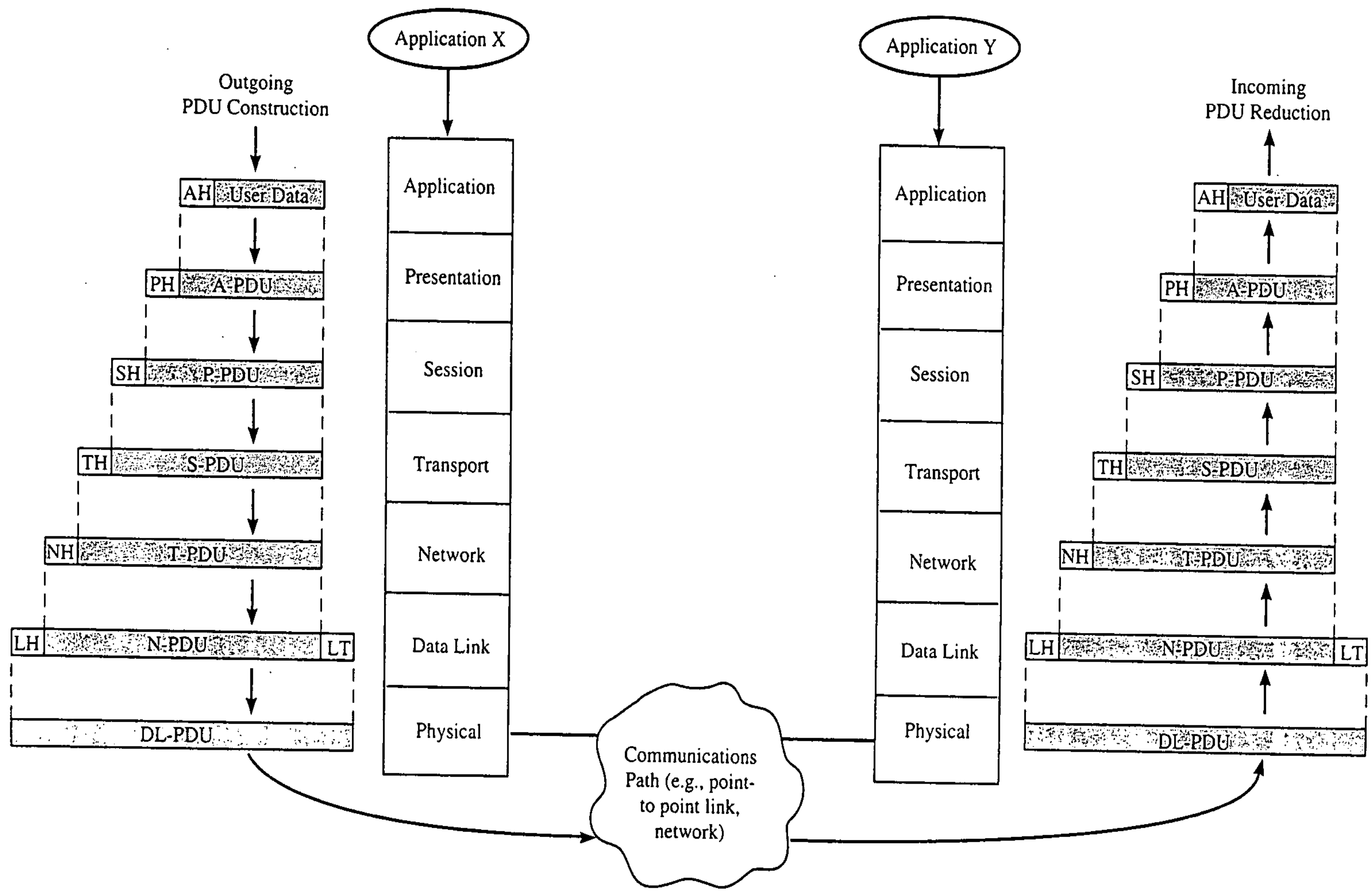


FIGURE 10.7. The OSI environment.

application Y, it invokes the application layer (layer 7). Layer 7 establishes a peer relationship with layer 7 of the target machine, using a layer 7 protocol. This protocol requires services from layer 6, so the two layer 6 entities use a protocol of their own, and so on down to the physical layer, which actually passes the bits through a transmission medium.

Note that there is no direct communication between peer layers except at the physical layer. That is, above the physical layer, each protocol entity sends data *down* to the next lower layer in order to get the data *across* to its peer entity. Even at the physical layer, the OSI model does not stipulate that two systems be directly connected. For example, a packet-switched or circuit-switched network may be used to provide the communications link. This point should become clearer below, when we discuss the network layer.

The attractiveness of the OSI approach is that it promises to solve the heterogeneous computer communications problem. Two systems, no matter how different, can communicate effectively if they have the following in common:

- They implement the same set of communications functions.
- These functions are organized into the same set of layers. Peer layers must provide the same functions, but note that it is not necessary that they provide them in the same way.
- Peer layers must share a common protocol.

To assure the above, standards are needed. Standards must define the functions and services to be provided by a layer (but not how it is to be done—that may differ from system to system). Standards must also define the protocols between peer layers (each protocol must be identical for the two peer layers). The OSI model, by defining a seven-layer architecture, provides a framework for defining these standards.

Some useful OSI terminology is illustrated in Figure 10.8. For simplicity, any layer is referred to as the *(N) layer*, and names of constructs associated with that layer are also preceded by (N). Within a system, there are one or more active entities in each layer. An *(N) entity* implements functions of the (N) layer and also the protocol for communicating with (N) entities in other systems. An example of an entity is a process in a multiprocessing system. Or it could simply be a subroutine. There might be multiple identical (N) entities, if this is convenient or efficient for a given system. There might also be differing (N) entities, corresponding to different protocol standards at that level.

Each entity communicates with entities in the layers above and below it across an *interface*. The interface is realized as one or more *service access points* (SAPs), which function in the manner of ports, discussed earlier. The (N − 1) entity provides *services* to an (N) entity via the invocation of *primitives*. A primitive specifies the function to be performed and is used to pass data and control information. The actual form of a primitive is implementation-dependent. An example is a subroutine call.

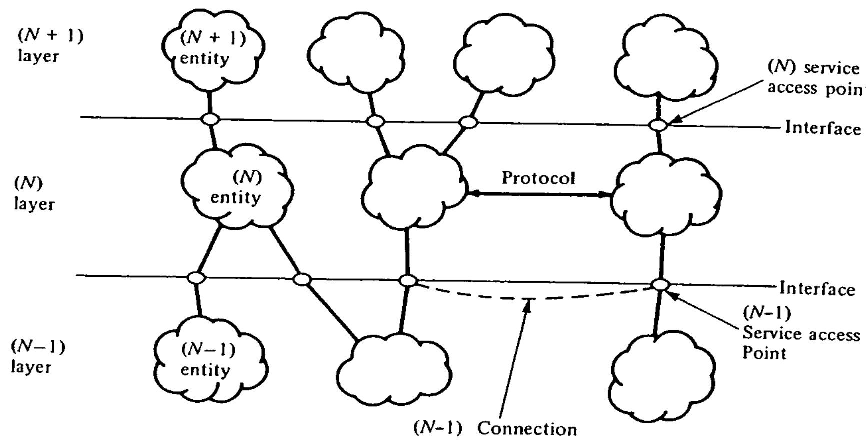


FIGURE 10.8. The layer concept.

The OSI model is connection-oriented. Two (N) entities communicate, using a protocol, by means of an (N − 1) connection. This logical connection is provided by (N − 1) entities between (N − 1) SAPs. ISO is currently at work on a connectionless mode, but this is not yet reflected in the model.

Figure 10.7 illustrates the OSI principles in operation. First, consider the most common way in which protocols are realized. When application *X* has a message to send to application *Y*, it transfers those data to an application entity in the application layer. A *header* is appended to the data that contains the required information for the peer layer 7 protocol (encapsulation). The original data, plus the header, is now passed as a unit to layer 6. The presentation entity treats the whole unit as data, and appends its own header (a second encapsulation). This process continues down through layer 2, which generally adds both a header and a trailer (e.g., HDLC). This layer 2 unit, called a *frame*, is then passed by the physical layer onto the transmission medium. When the frame is received by the target system, the reverse process occurs. As the data ascend, each layer strips off the outermost header, acts on the protocol information contained therein, and passes the remainder up to the next layer.

At each stage of the process, a layer may fragment the data unit it receives from the next higher layer into several parts, to accommodate its own requirements. These data units must then be reassembled by the corresponding peer layer before being passed up.

When two peer entities wish to exchange data, this may be done with or without a prior connection. We have seen an example of this in the use of virtual circuits or datagrams. A connection can exist at any layer of the hierarchy. In the abstract, a connection is established between two (*N*) entities by identifying an (*N* − 1) SAP for each (*N*) entity.

Physical Layer

The *physical layer* covers the physical interface between devices and the rules by which bits are passed from one to another. The physical layer has four important characteristics [BERT80, MCCL83]:

- Mechanical.
- Electrical.
- Functional.
- Procedural.

We have already covered physical layer protocols in some detail in Section 4.3. Examples of standards at this layer are EIA-232-D, EIA-530, and portions of ISDN and LAN/MAN standards.

Data Link Layer

While the physical layer provides only a raw bit stream service, the *data link layer* attempts to make the physical link reliable and provides the means to activate, maintain, and deactivate the link. The principal service provided by the link layer to the higher layers is that of error detection and control. Thus, with a fully functional data link layer protocol, the next higher layer may assume virtually error-free transmission over the link. However, if communication is between two systems that are not directly connected, the connection will comprise a number of data links in tandem, each functioning independently. Thus the higher layers are not relieved of an error control responsibility.

Chapter 5 was devoted to data link protocols. Examples of standards at this layer are HDLC, ADCCP, and LAP-B.

Network Layer

The network layer provides for the transfer of information between end systems across some sort of communications network. It relieves higher layers of the need to know anything about the underlying data transmission and switching technologies used to connect systems. At this layer, the computer system engages in a dialogue with the network to specify the destination address and to request certain network facilities, such as priority.

Communications across a network between processes in separate systems can be thought of as involving two kinds of entities:

- The end systems, which contain the processes and implement some sort of communications architecture, such as the seven-layer OSI architecture.
- The nodes, or switching systems, of the network, which manage communication across the network.

In most cases, an end system attaches to a communications device that is considered, from an architectural point of view, to be part of the network. CCITT refers to an end system and the communications device to which it attaches as data terminal equipment (DTE) and data circuit-terminating equipment (DCE), respectively.

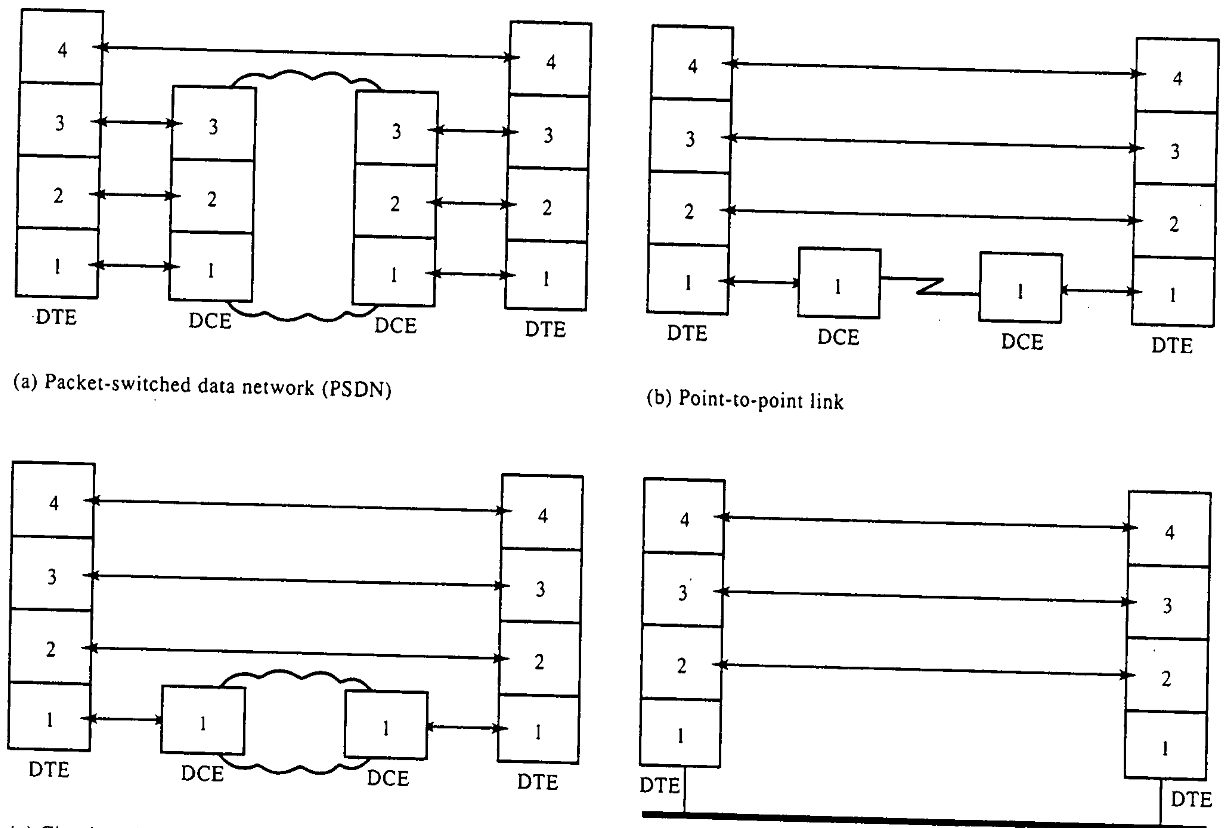
To understand the protocol implications of the requirement for network attachment, we need to look at the various possible cases. Figure 10.10a depicts the case in which an end system (DTE) attaches to a packet-switching node (DCE) that is part of a packet-switched network. As an example, the packet layer of the X.25 standard is a network layer standard for this situation. The lower three layers are concerned with attaching to and communicating with the network. The packets that are created by the end system pass through one or more network nodes, which act as relays between the two end systems. Note that, in addition to a layer 3 protocol, a data link layer protocol (layer 2) over a physical link (layer 1) between the DTE and DCE is needed. Hence, the DTE–DCE interaction consists of protocols at layers 1, 2, and 3. The local DCE uses a different set of protocols to route data units through the network to the destination DCE, which in turn has a layer 1–3 set of protocols with the destination DTE. The internal operation of the network is transparent to the user, and the internal protocol structure in the network is of no concern to the end systems.

A quite different circumstance is illustrated in Figure 10.10b, which shows two DTEs connected by a point-to-point link. Typically, this configuration also involves the use of DCEs. There is a standardized physical-level interface, such as EIA–232–D, between the end system and a DCE (e.g., a modem), and the two DCEs communicate using some other physical protocol across a transmission line (see Figure 4.8). In this case, the DCE operates purely at layer 1 and simply relays the bits from the DTE onto the transmission line and vice versa. Thus, layers 2 and 3, as well as layer 4, are end to end, or DTE to DTE. In this configuration, the layer 3 protocol has very little work to do. There are no network facilities to request, and there is no need for address information to support routing.

A similar situation exists in the case of a circuit-switched network (Figure 10.10c). Once a circuit has been set up between two DTEs across the network, it appears to the two stations that they have a direct point-to-point link. The nodes of the network act simply as layer 1 relays of the bits being transmitted. Again, very little is needed at layer 3.

The architecture of a LAN or MAN is depicted in Figure 10.10d. The layer 2 protocols are end to end between attached devices. So, once again, the LAN acts simply as a layer 1 facility for moving bits between two DTEs. In this case, there is no readily identifiable DCE; the DTEs connect directly to the shared network medium. As in the preceding two cases, there is not a great deal for a layer 3 protocol to do.

In a more complex configuration, two end systems might wish to communicate but are not even connected to the same network. Rather, they are



(a) Packet-switched data network (PSDN)

(b) Point-to-point link

(c) Circuit-switched data network (CSDN)

(d) Local area network (LAN)

FIGURE 10.10. Network interface architecture.

connected to networks that, directly or indirectly, are connected to each other. This case requires the use of some sort of internetworking technique; we explore this approach in Chapter 11.

The best known example of layer 3 is the X.25 layer 3 standard, which is examined in some detail in Chapter 9. The X.25 standard refers to itself as an interface between a station and a node (using our terminology). In the context of the OSI model, it is actually a station-node protocol.

Transport Layer

The purpose of layer 4 is to provide a reliable mechanism for the exchange of data between processes in different systems. The *transport layer* ensures that data units are delivered error-free, in sequence, with no losses or duplications. The transport layer may also be concerned with optimizing the use of network services and providing a requested quality of service to session entities. For example, the session entity might specify acceptable error rates, maximum delay, priority, and security. In effect, the transport layer serves as the user's liaison with the communications facility.

The size and complexity of a transport protocol depends on the type of service it can get from layer 3. For a reliable layer 3 with a virtual circuit capability, a minimal layer 4 is required. If layer 3 is unreliable and/or only supports datagrams, the layer 4 protocol should include extensive error detection and recovery. Accordingly, ISO has defined five classes of transport protocol, each oriented toward a different underlying service. The most complex version is comparable in capability to another transport protocol standard. DOD's Transmission Control Protocol (TCP). All of these standards are discussed in Chapter 12.

Session Layer

The lowest four layers of the OSI model provide the means for the reliable exchange of data and provide an expedited data service. For many applications, this basic service is insufficient. For example, a remote terminal access application might require a half-duplex dialogue. A transaction-processing application might require checkpoints in the data-transfer stream to permit backup and recovery. A message-processing application might require the ability to interrupt a dialogue in order to prepare a new portion of a message and later to resume the dialogue where is was left off.

All these capabilities could be embedded in specific applications at layer 7. However, since these types of dialogue-structuring tools have widespread applicability, it makes sense to organize them into a separate layer: the session layer.

The session layer provides the mechanism for controlling the dialogue between applications in end systems. In may cases, there will be little or no need

The inventor hereby repeats its claim that US Patent 4,918,690 is fundamentally not relevant (both specifications and claims) to the patent application discussed, and that anyone having minimum knowledge in the communication arena would agree that this patent cannot be cited against the application.

Since there is apparently a wide gap between the examiner and the applicant perception of the application and its position versus the cited objections, the applicant hereby request a face-to-face meeting to try to bridge the gap.

GENERAL.

Common way to differentiate between network involves using the the Open Systems Interconnection (OSI) reference model, adopted in 1983 by the International Organization for Standardization (ISO). Model description and explanation can be found in any basic communication book, or in the full standard which is published as ISO7498: Basic Reference Model for open Systems Interconnection (1984).
Sample explanation about this model is attached as pages 436-450 of the book Data and Computer Communication, fourth Edition, by William Stallings (Prentice Hall International ditions).
The lower layers are relevant to our case, and are defined as follows (Table 10.4 of Stallings book, Page 438):

1. The Physical layer (Layer 1): Concened with transmission of unstructured bit stream over physical medium; deals with the mechanical, electrical, functional and procedural characteristics to access the physical medium.
2. The Data Link layer (Layer 2): Provides for the reliable transfer of information across the physical link; Sends blocks of data (frames) with the necessary synchronization, error control, and flow control.
3. The Network layer (Layer 3): Provides upper layers with independnce from the data transmission and switching technologies used to connect systems; responsible for establishing, maintaining, and terminating connections.
4. The Transport layer (Layer 4): Provides reliable, transparent transfer of data between end points; provides end-to-end error recovery and flow control.

The applicant's basic argument is that anyone, having a minimum understanding in the communication field, understands that the application deals with physical layer (Layer 1), while Markkula, Jr et al. US Patent 4,918,690 specifically deals with layer 2 and above, and as such cannot be relevant to the application.

The following arguments support the claim that Markkula et al. deals with Layer 2 and aboves layers:

1. Throughout the patent text, the terms 'packet' and 'address' are being used. Furthermore, claim 1 specifically deals with '... unique cell identification number, ...'. Packets and addresses are classic Layer 2 and above issues, since structured bit stream is required. Furthermore, claim 1 specifically cals for ' ... group of said cells being programmed to performed group functions..'. Such group function is by definition Layer 4 and above functions.

2. Markkula et al. patent text itself is ot limited to any media or protocol, as stated (Coloumn 4, lines 44-59):

" In FIG. 1, the transceivers **29** and **33** communicate over power lines. The transceivers may communicate with one another in numerous different ways over countless media and at any baud rate. They may, for example, each transmit and receive radio frequency for microwave frequency signals through antennas. The transceivers could be connected to a communications lines, such as an ordinary twisted pair or fiberoptic cable and thus communicate with one another independent of the power lines. Other known communications medium may be employed between the transceivers such as infrared or ultrasonic transmissions. Typical transmission rates are 10K bits per second (KBPS) for power lines. Much higher transmission rates are possible or radio frequency, infrared, twisted pairs, fiberoptic links and other media."

And also coloumn 1 lines 44-48: "... The cells can be coupled to different media such as power lines, twisted pair, radio frequency, infrared ultrasonic, optical coaxial, etc., to form a network."

3. Even the Markkula et al. patent classification refer to Layer 2 innovation, specifically US Class 370/94 (currently 370/400) and International H04J 3/26, defined as follows:

Subclass: 400
Having a plurality of nodes performing distributed switching:
This subclass is indented under subclass 389. Subject matter having a switching architecture in which a plurality of switch nodes are provided such that the switching function is spread out over a geos:graphical area.

Subclass: 389
Switching a message which includes an address header (e.g., packet switching):
This subclass is indented under subclass 351. Subject matter wherein information data to be switched is organized with one or more bytes preceded by an identification information indicative of a source or destination station.
(1) Note. The switching of the message having an address header is commonly called packet switching.

All above classifications specifically deals with Layer 2 and above.

4. Neither the cell overview (part III-A, coloumns 17-18) nor the figures describing the cell (figures 10-23) comprise or refer to the transceiver, which is the function in

charge of dealing with interfacing the communication media. Furthermore, figure 1 specifically shows that the cells (numbered 27 and 28) are not including the transceiver (29,33) and power supply (30,31), denoting that physical layer item (transceiver) are not part of the cell, which exclusively deals with higher layers *(this is also upported by the figures description).

All four items cited above, as well as dozens in the patent application, supports the argument that this patent is not dealing with physical layer. Figures 2, 3, 4 and 5 in Markulla et al. patent, which are cited against the application, are, as also explained in the specification, **not** an actual physical connections (physical layer) but exhibit logical connections only (connections at higher layers). Only Figure 4 mention actual connection by means of subchannels, as per the subchannel definition, and is used only to demostrate that actual connections (subchannels) are totally decoupled from groups, which are are formed by logical onnections.

SPECIFIC RESPONSE.

a. The examiner says:

" Markulla, Jr. et al, in fig.5, shows that each of said each of said electrically-conducting media interconnects no more than two of the said serial intelligent cells, for instance, the media 59 interconects two cells 60 and 61 (it meets the claimed limitations in parts (a), (B) and (c), likewise for other cells (see col. 7, lines 36-39)."

Response:

The examiner attention is to be drawn to the end of the cited paragraph, coloumn 7 lines 46-62, saying:" Importantly, however, announcer 60 and listener 65 are in different subchannels of the channel of FIG.5 and there are numerous routes by which a message can be passed from announcer 60 to listener 65, for example, through cells 61 and 64 or through cells 62 and 64, etc.
Note than even though all the cells are on the same power sustem of the house, they may not communicate directly with one another..."

Subchannel is defined (in coloumn 6 lines 24-33) as cells sharing the same communication medium. This (as well as other places in the text) shows that Fig.5 is **not** describing a physical connection but a logical connection, hence cannot be cited against the application.

b. The examiner says:

" first of all, the meaning of "bidirectional communication" is two-way communication".

Background:

As known in the art, and looking at Stallings, Page 34: " A transmission may be simplex, half-duplex, or full duplex. In *simplex* transmission, signals are transmitted in only one direction; one station is transmitter and the other is receiver. In *half-duplex* operation, both stations may transmit, but only one at a time. In *full-duplex* operation, both stations may transmit simultaneously. In the latter case, the medium is carrying signals in both directions in the same time."

Hence, two cases can be considered:

a. The case wherein **two and no more than two** cells are connected to a shared media. In such a case, simplex, half-duplex and full-duplex operations are enabled at all times.
b. The case wherein **two or more** cells are connected to a shared media. In such a case only simplex and half-duplex operations are enabled at any time.

It should be noted that also half-duplex operation supports bidirectional data transfer, wherein at a one time data is carried only from cell A to cell B, and at other time data is carried only from cell B to cell A.

In the general case, wherein single spectrum band is used, full duplex operation can only be enabled in the case wherein two and only two units share the same communication media. In such a case, contention or collision cannot happen.

Wherein three or more cells are sharing the same communication media, full duplex operation cannot be enabled by definition. In such a case, half-duplex is usually used, and contention / collision may occurr, if the cell's transmitter are not synchronized.

Our case:

The application specifically refer to a network based on wired media segments, wherein two, **and only two** units are connected to each segment. As such, full-duplex operation is enables, and collision / contention state is inherently obviated.

First of all, Markulla et al. deals with layers 2 and above, and as such do not involves with which transport mechanim (either half-duplex or full-duplex) is used, as long as data is exchanged between cells.

Wherein Markulla refer to physical layer as an example, he refers to 2 or more cells sharing the same media, hence supporting half-duplex, and requiring solutions for solving contention / collision states. This can also be demonstrated by the fact that wherever transceiver is mention, it is always a single transceiver, while the application require a transceiver per connected media.

c. **The examiner says:**

" In col. 7, lines 63-67, Markulla et al teach that interference do not occur when two cells communicate to each other on different channels/subchannels (i.e., the cell can communicate bidirectionally and independently of the comunication of other cells)."

Response:

The full paragraph says (Coloumn 7 lines 63-68):

" For the following description, it is assumed that each of the cells can broadcast without interfering with the broadcast of other cells. That is, messages do not interfere with one another. The case where some contention occurs is dealt with under the protocol section of this application."

This should be added to the protocol description (chapter V) in coloumns 68 to 72, wherein a protocol supporting and handling collisions / contentions is described.

The cited paragraph, also in view of the former paragraph and in context of the application, only teaches half-duplex operation, wherein single transmitter operates at a time, and that a mechanism should be employed to solve contention. This does not teach any independent communication whatsoever.

d. The examiner says:

" - As to claims 21,28 and 31, in Markulla, Jr. et al, each cell (20) comprises: a line interface, a modem (111), a control block (100); and a power supply (30), and each cell further comprises a communications interface (29) and a telephone interface (not shown).
- As to claims 27,52, 57 and 59, in Markulla, Jr. et al, each cell (20) comprises: a line interface, a modem (111), a control block (100); and a power supply (30), and each cell further comprises a communication/payload interface (29) and a sensor/actuator."

Response:

a. First of all, according to figure 1, the cells are 27 and 28. Items 20 and 21 are not cells, but rather include cells 27 and 28, accordingly.
b. Item 111 in figure 10 is a timing generator and not a modem as the examiner states, as also explained in coloumn 18 lines 23-25.
c. All cells (or units) described throughout the text include single transceiver/modem, while the application specifically demand at least two transceivers.

e. The examiner says:

" – As to claims 21, 28 and 31, in Markkula Jr. et al, each cell (20) comprises: a line interface, a modem (111), a control block (100); and a power supply (30), and each cell further comprises a communications interface (29) and a telephone interface (not shown)."

" – As to claims 12-13, it is inherent that in Markkula, Jr. et al, at least one cell is housed within a telephone outlet, and said outlet allows connections to telephone services and to the local area network (see Appendix C in col. 86)."

Response:

Throughout the Markkula patent, the work 'telephone' does not appear. The only mentioning is at col.86 under **APPLICATIONS** as follows:

Phone I.D. (Cell I.D.)
Phone to cell bridge

The applicant believes that such minor citing under 'applications' cannot be any citing against the application, and for sure do not indicate using the telephone line as a communication media.

Response to Sutterlin et al, cited:

a. **The examiner says:**

"Sutterlin et al, in figs 3-4 and the description associated with the figs, disclose a LAN network for data communication, sensing, and control comprising conditions (a)-(c) and at least one of said SICs receives electrical power via the electrically-conducting media."

Response:

1. Fig. 4 at Sutterlin et al, is not describing a network but rather a current flow as explained in Col. 3 lines 32-33 and in the Fig. Description at Col. 5 lines 44-68, hence this figure is not relevant to the applicant case.

2. While Fig. 3 seems to meet conditions (a)-(c), is also not relevant to our case since:

- The figure describes a single point-to-point connection rather than a full network, as can be seen from the Figure itself and from the explanation in Col. 5 lines 15-25.
- The Figure describes unidirectional communication (having a transmitter Tx-21 in one end and receiver Rx-22 at the other end, as also explained in Col. 5 lines 19-20: " The circuit schematic diagram of Fig. 3 comprise a transmitter 21 and a receiver 22.". This is also apparent in Claim 1, Col.9 lines 60-61, "...a message information from a transmitter to a receiver ...".

Since the applicant describes both a network having multiple communication segments (not limited to single point-to-point connection) and bi-directional communication, this figure is not relevant and cannot be cited against the application.

In addition, Sutterlin et al. does not imply any application wherein the network is based on existing wiring within a house, such as telephone, power or others. Furthermore, Sutterlin et al. specifically describes DC powering of the network, and this is the main essence of the invention described, as shown in all the figures and their description, in the summary of the invention, and in all the claims. Such DC power can neither be used in telephone wiring wherein the DC powering is

used by the telephone system, nor in mains power carrying wires wherein such circuitry is expected at least to burn and malfunction.

Hence, it is the applicant view that Sutterlin et al. is not relevant to the application, and cannot be obvious to ones skilled in the art at the time of the invention was made to apply Sutterlin et al, teaching in Markkula, Jr. et al,. However, in order to remove any doubt, the applicant suggests to amend the claims to reflect a network rather than single point to point topology system, as follows:

1. Change claims 1, 35, 36 to say:

" ... comprising at least three serial intelligent cells interconnected exclusively by electrically conducting media into at least two communication pairs, ...".